DOCUMENT RESUME

ED 155 858 EC 110 739

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TITLE Musical Perception in the Assessment of Cognitive Devolpment.
PUB DATE 78
NOTE 20p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Childhood; *Cognitive Development; *Conservation (Concept); *Developmental Disabilities; Elementary Education; *Evaluation Methods; Exceptional Child Research; *Music; Test Construction; *Visually Handicapped

ABSTRACT

Two experiments invclving 40 developmentally disabled children (7 to 13 years old) and 32 normal schocl children (from grades 2-5) were designed to produce a cognitive assessment tool, based on musical conservation tasks, which would be particularly useful with visually handicapped children. Implicatcns frcm the research were that these tasks provide music educators and therapists with a tool for determining developmental readiness needed for such cognitive-musical behaviors as note-reading, improvisatcn, and composition; that these tasks provide informatin concerning readiness for non-musical behaviors involving logicc-mathematical operations; that this research establishes a cognitive assessment and training model for visually handicapped children; and that these tasks, in combination with Piagetian materials, provide a multisenscry developmental training curriculum for normal and developmentally disabled children. (SBH)

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MUSICAL PERCEPTION IN THE ASSESSMENT OF COGNITIVE DEVELOPMENT

By Mark S. Rider*

Problem and Purpose

The relationship between cognitive development and musical development has been investigated by a number of authors. This type of research originated in correlational studies between I.Q. and music ability. Generally, there has been found to be a low, but positive correlation between intelligence tests and music ability tests (Farnsworth, 1969; Lundin, 1967; Mursell, 1971). This relationship, however, does not warrant the use of musicality to predict intelligence.

Other authors have begun to investigate the process of musical development in much the same way that Piaget approached cognitive development. Larsen (1973) found that the mechanism which enabled children to seriate resonator bells according to pitch became more developed with age. Pflederer (1964) studied the development of musical concepts such as melody, rhythm, and meter through the application of Piaget's conservation principle to music learning. She found that the ability to conserve (recognize) a concept, e.g., melody, under deformations in another concept, e.g., rhythm, was developmental.

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Conservation in many of these studies of musical development has not been utilized in the strict Piagetian sense. For example, the concepts of melody and rhythm are not quantitative attributes, as are mass and weight. Thus, the ability to recognize a melody in different rhythmic contexts would appear to involve perceptual, as well as cognitive, processes. This phenomenon was exhibited in research by Zimmerman and Sechrest (1970), Botvin (1974), and Foley (1975) in which training procedures were found to significantly increase conservation-type responses in elementary school-aged children.

Jones (1976) investigated musical development in children by utilizing Piaget's theory of temporal development. He devised note-reading tasks corresponding to the ordinal, hyper-ordinal, and metric stages (Piaget, 1964) in the conceptualization of time in music. Results indicated that the tasks were developmentally scalable and that children did not understand the mathematical relationships in musical meter until about age 11, or formal operations.

Perney (1977) reproduced Jones' study using 5 of the 11 original tasks. Her results did not confirm the existence of a scalable set. However, it was noted that there were no statistically significant differences of task performance between children who had and had not received training on a musical instrument.

The ultimate hope for a musical assessment of cognitive development is reflected in Perney's finding of "no training

effects," i.e., a valid testing instrument should be independent of musical aptitude or musical training. The apparent lack of specific developmental sequences in musical concept development, e.g., rhythm before melody, etc., is perhaps caused by the confounding effects of perception--sensory acuity, rhythmic integration, and musical memory--upon the pure cognitive processes which are involved in music.

The purpose of the two experiments reported in this paper was to design musical conservation tasks which utilize only cognitive processes, i.e., would be independent of perceptual processes. These tasks, unlike Jones', were to rely only upon the auditory mode. It was this author's intention to produce a cognitive assessment tool which would be particularly useful with visually handicapped children.

Experiment I - Method

The first study utilized 40 developmentally disabled (primarily cerebral palsied) children at the University Affiliated Center in Dallas, Texas. The children were between the ages of 7-13, with CA = 9.5 and MA = 8.1. All children were individually administered two musical conservation tasks, rhythm (CR) and tempo (CT), and two Piagetian conservation tasks, area (CA) and continuous volume (CCV).

CR (Figure 1) consisted of a constant speed drumbeat accompanied by a melody ("Row, Row, Row Your Boat") consecutively played at two different tempos. The child was required to maintain, with a justification, that the drumbeat had a uniform speed in spite of changes in the melodic tempo.

CT (Figure 3) consisted of two rhythmically-pulsed auditory stimuli first playing in unison, and then moving out of phase (syncopated). To pass this task, the child was required to maintain, with a justification, that the two stimuli were moving at the same speed regardless of position. Each of the tasks utilized resonator bells and a drum for the two stimuli.

The CA and CCV tasks were found by Burk (1973) to occur around ages 7½ and 8, respectively. CA required the child to maintain that the total area covered by 1" squares was the same regardless of how the squares were arranged. CCV required the child to maintain that the amount of water was the same, regardless of the size and shape of the container.

Experiment I - Results

Scalogram analysis indicated that the four tasks formed a scalable set with a reproducibility coefficient (R) of .98 and a scalability coefficient of .94. An $R \leq .9$ is necessary for scalability. The developmental order of the tasks was:

$$CR \rightarrow CA \rightarrow CCV \rightarrow CT$$

The acquisition ages of CR and CT were estimated from determining the strength of the relationship among the four tasks, and comparing these to the known ages of the CA and CCV tasks. All of the phi correlations between any two tasks were significant at the .01 level. CR was estimated at 6 years-10 months, and CT at 8 years-3 months.

Experiment II - Method

In the second study, four musical conservation tasks, three Piagetian conservation tasks, and a musical aptitude test were administered to 32 "normal" public school children from grades 2-5.

The musical conservation tasks were taken from the "Musical-Perception Assessment of Cognitive Development" (M-PACD). (See Rider, 1978). Two of these tasks, CR and CT, were discussed in Experiment I. The melody used in the CR task was changed in Experiment II to "London Bridge is Falling Down."

Conservation of auditory number (CN) consisted of a short melodic phrase ("London Bridge...") consecutively played at two different tempos. The child was required to maintain, with a justification, that each phrase had the same number of notes (bells), regardless of the tempo changes. (See Figure 2)

Conservation of duration (CD) consisted of a melody and drumbeats which started and stopped simultaneously, but whose tempos differed. The child was required to maintain, with a justification, that the total times to play either the melody (bells) or the drumbeats were equal, regardless of the difference in tempos. (See Figure 4.)

The three Piagetian tasks were the conservations of mass (CM), weight (CW), and volume (CV). All three tasks utilized balls of plasticene, one of which was deformed in shape and compared to the unchanged ball according to the three attributes--

mass, weight, and volume. The CV task additionally used two equal flasks of water into which the plasticene was immersed and compared by means of the water displacement in each flask.

The Musical Aptitude Profile (Gordon, 1965) "Tempo" subtest was given to all of the children to determine whether or not the M-PACD tasks were independent of musical aptitude. A musical phrase was played once and then repeated at a tempo which was either the same as or different from the original playing.

Experiment II - Results

The M-PACD and Piagetian conservation tasks were subjected to Guttman scalogram analysis. The M-PACD tasks scaled in the order of CR → CN → CT → CD ($\underline{R}$ = .95). The Piagetian tasks also scaled in the expected order of CM CW CV ($\underline{R}$ = .98).

Table 1 also indicates in scales #3, 4, and 5 that the scalability ($\underline{R} \leq .9$) was maintained in substituting individual M-PACD tasks for Piagetian tasks. The following substitutions were indicated:

1. CR for CM,
2. CN for CW, and
3. CT for CV.

Scale #6 represents a combination of all 7 tasks. The $\underline{R}$ (.88) was not high enough for scalability, suggesting that strict developmental relationships do not exist between different senses.

The validity of the M-PACD tasks was evidenced first by the fact that mean "Tempo" scores did not differ significantly between conservers and non-conservers. (See Table 2.) However, for some of the age groups, either all or none of the children passed the task (CR and CD, particularly), making it impossible to compare scores.

Kendall partial-correlational analysis enabled a validity check for the test as a whole. Keeping age constant, the correlation (τ) between the M-PACD and Piaget tests was quite high at .63, while the correlation between the M-PACD and "Tempo" tests was .36. (See Table 3.) Although this last correlation is still significant ($p < .01$), it should be pointed out that this correlation was not much higher than that between the Piaget and "Tempo" tests, .30 ($p < .01$). Thus, the M-PACD appears to be relatively independent of musical aptitude.

The ages of acquisition of the seven tasks were determined by finding the age at which a 50% conservation-response rate occurred. These were as follows:

M-PACD

1. CR--7½ years
2. CN--8½ years
3. CT--10 years
4. CD--10½ years

Piaget

1. CM--7½ years
2. CW--9 years
3. CV--10½ years

Conclusions

The most important conclusion from this study was the fact that a valid music therapy assessment instrument was established. Also, the information gained from the scalability of the M-PACD tasks indicated that the M-PACD can be used in place of the Piaget test, for the assessment of cognitive development.

If, when tested, a child failed all of the M-PACD tasks, one could conclude that the child was cognitively at the preoperational level, characteristic of perceptually-bound, time-limited thinking. Operational thinking characteristic of reversibility and concept differentiation, would be the assessment if the child were to pass up to three M-PACD tasks (CR, CN, and CT). Finally, the person would be ready for formal operational, or hypothetico-deductive, thinking if he were to pass all four of the M-PACD tasks. At this stage, the adolescent would not be bound to concrete events for information, but could utilize his operational knowledge of concepts in an abstract manner.

The purpose of developing an auditory assessment tool, such as the M-PACD, was not to replace the visual tests already in existence, but to supplement them, e.g., in assessing the cognitive development of a visually handicapped person. The conservations of rhythm and tempo may be used as substitutes for the conservations of mass and volume respectively. Although the conservation of auditory number (about age 8½) may also

be substituted for the conservation of weight, it seemed to precede the latter by about six months, and therefore, should be used not as a replacement, but as a supplement, to gain diagnostic information which will enable the therapist to pinpoint more preceisely the cognitive-developmental level of the child.

The scalability of the M-PACD tasks provided conclusive support for yet another aspect of Piaget's developmental model (besides the conservation tasks). The number (CN), tempo (CT), and duration (CD) tasks were designed to correspond to Piaget's displacement, velocity, and time experiments, respectively (Piaget, 1969). The results of this study supported Piaget's theory that children develop the three concepts in the given order, i.e., CN, CT, and CD. The fact that these same sequences exist in more than one perceptual mode adds even more strength to Piaget's model of the development of the concept of time in children.

Implications

Implication from this research span many different disciplines. Some of these are as follows:

1. These tasks provide music educators and music therapists with a tool for determining developmental readiness needed for such cognitive-musical behaviors as note-reading, improvisation, and composition.
2. These tasks provide information concerning readiness for non-musical behaviors involving logico-mathematical

operations.

3. This research establishes a cognitive assessment and training model for visually handicapped children.
4. These tasks, combined with Piagetian materials, provide a multi-sensory developmental training curriculum for normal and developmentally disabled children.

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Preliminary question: Do the bells in the first melody (#1) play faster, slower, or the same speed as the bells in the second melody (#2)?

Conservation question: Do the drumbeats in the first melody (#3) play faster, slower, or the same speed as the drumbeats in the second melody (#4)? Why?

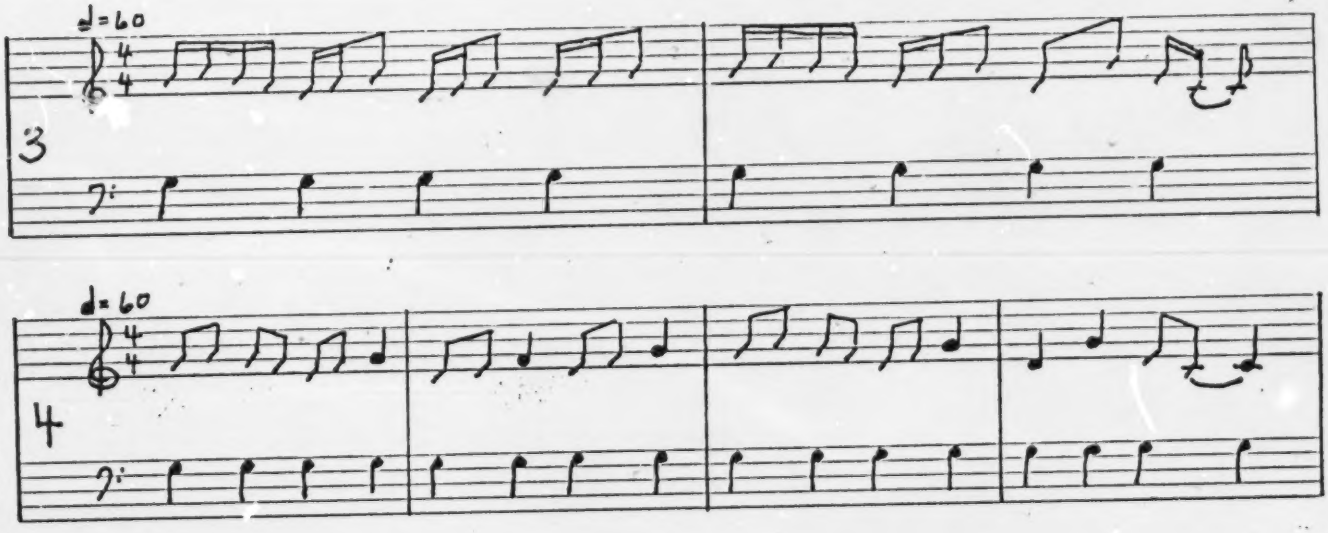
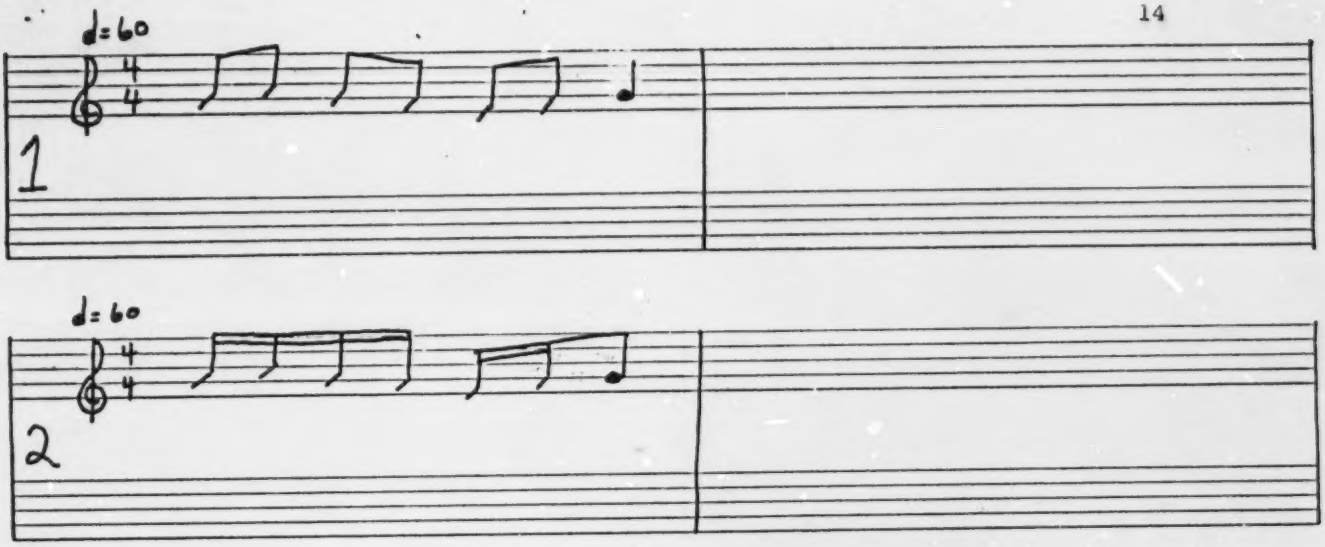


Figure 1. Conservation of rhythm. The "𝄞" and "𝄢" clefs represent the bells and drumbeats, respectively.



Preliminary question: Do the bells in the first melody (#1) play faster, slower, or the same speed as the bells in the second melody (#2)?

Conservation question: Are there more, less, or the same number of bells in the first melody (#3) as in the second melody (#4)? Why?

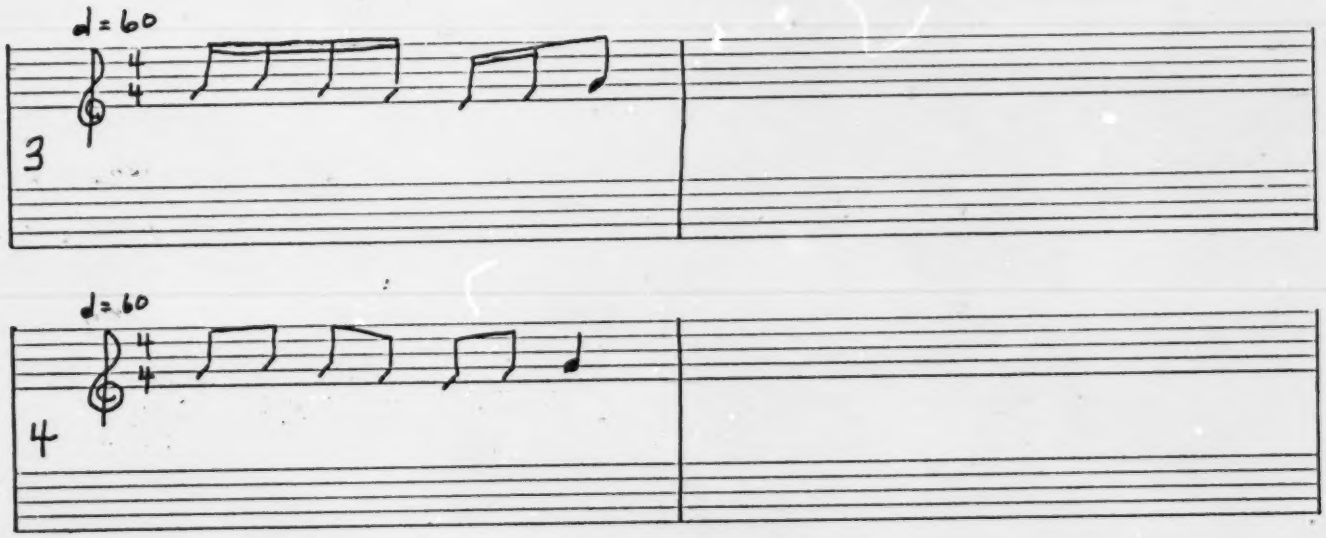
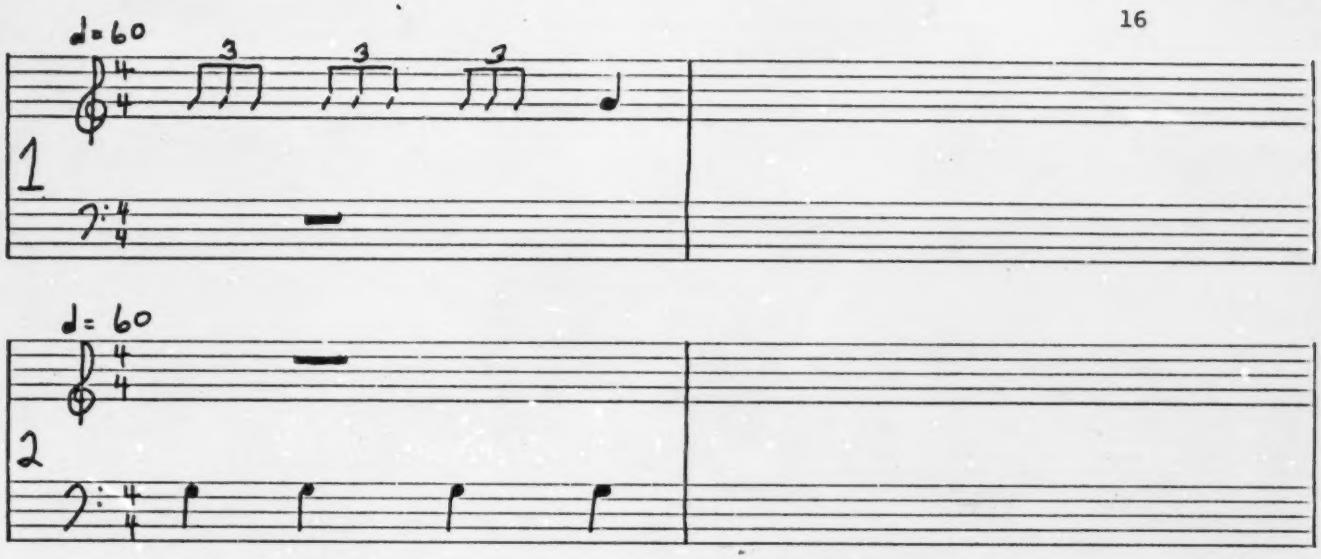


Figure 2. Conservation of auditory number.

Preliminary question: Are the bells traveling faster, slower, or the same speed as the drumbeats (same question for #1 and #2)?

Conservation question: Are the bells traveling faster, slower, or the same speed as the drumbeats (same question for #3 and #4)? Why?

Figure 3. Conservation of tempo. The "𝄞" and "𝄢" clefs represent the bells and drumbeats, respectively.



Preliminary question: Do the bells (#1) take more, less, or the same amount of time as the drumbeats (#2) to play all of their notes? (#1 is played either before or after #2.)

Conservation question: Do the bells take more, less, or the same amount of time as the drumbeats to play all of their notes (same question for #3 and #4)? Why?

Figure 4. Conservation of duration. The "𝄞" and "𝄢" clefs represent the bells and drumbeats, respectively.

Table 1

Guttman Analysis of Auditory, Visual and Auditory-Visual Conservation Scales

Conservation Scale*	R	S
1. CR, CN, CT, CD**	.95	.82
2. CM, CW, CV	.98	.94
3. CR, CW, CV	.96	.87
4. CM, CN, CV	.94	.79
5. CM, CW, CT	.96	.87
6. CR, CM, CN, CW, CV, CT, CD	.88	.57

*All scales are in developmental order.

**The underlined tasks are from the M-PACD.

Table 2

Comparison of Mean MAP ("Tempo") Scores Between Conservers (C) and Non-Conservers (NC) on All M-PACD Tasks and in All Grades

Conservation Task and Grade	MAP_C	MAP_{NC}	t(df=6)	p
CR				
2nd grade	26.75	25.50	.50	NS
CN				
2nd grade	28.67	24.60	2.07	NS
3rd grade	33.75	30.50	1.87	NS
4th grade	33.20	32.67	.33	NS
5th grade	32.83	32.00	.22	NS
CT				
3rd grade	31.33	32.6	.55	NS
4th grade	31.50	33.50	1.23	NS
5th grade	35.25	30.00	2.05	NS
CD				
5th grade	35.25	30.00	2.05	NS

Table 3

Kendall Full and Partial Rank Correlations

Variables Correlated	τ	derived z^*	p
1. Age x Piaget	.22	1.79	.0367
2. Age x M-PACD	.36	2.89	.0019
3. Age x MAP	.36	2.89	.0019
4. MAP x Piaget	.35	2.84	.0023
5. MAP x M-PACD	.45	3.59	.00017
6. M-PACD x Piaget	.65	5.25	.00001
7. MAP x Piaget · age	.30	2.37	.0089
8. MAP x M-PACD · age	.36	2.87	.0021
9. M-PACD x Piaget · age	.63	4.97	.0001

*all z values are one-tailed.